WHAT IS CLAIMED IS:

1. A method of manufacturing a nano-gap electrode comprising:

depositing an electrode layer and a metal mask layer in this order on an insulating substrate;

etching the metal mask layer using a focused ion beam and thereby forming a mask pattern;

transferring the mask pattern to the electrode layer by dry etching the electrode layer to form the nano-gap electrode; and

selectively removing the metal mask layer from the nano-gap electrode by selective wet etching.

2. The method of claim 1, further comprising a step of forming an adhesion layer between the insulating substrate and the electrode layer for enhancing adhesion of the electrode layer to the insulating substrate.

3. The method of claim 1, wherein the thickness of the electrode layer is larger than a maximum ion penetration length of the focused ion beam in the mask pattern forming step.

4. The method of claim 1, wherein the thickness of the metal mask layer ranges from 10 nm to 400 nm.

5. The method of claim 1, wherein ions impact against the metal mask layer at a dose from 10^{15} to 10^{21} ions/cm^2 in the mask pattern forming step.

6. The method of claim 1, wherein not only the metal mask layer but also the electrode layer is removed by 1 nm to 40 nm on an average in the pattern forming step.

7. The method of claim 1, wherein a gap between electrode portions ranges from 2 nm to 12 nm.

8. The method of claim 1, wherein the metal mask layer comprises Ti.

9. The method of claim 1, wherein the electrode layer comprises Au.

10. The method of claim 1, wherein the focused ion beam comprises a gallium ion beam accelerated by an applied voltage from 10 kV to 200 kV.

11. The method of claim 1, wherein the focused ion beam has a minimum diameter from 5 nm to 100 nm.

12. The method of claim 1, wherein a gap between electrode portions is less than one half of the minimum focused ion beam diameter.

13. The method of claim 1, wherein a gap between electrode portions ranges from 2 nm to 10 nm.

14. The method of claim 1, wherein a gap between electrode portions ranges from 4 nm to 6 nm.

15. A method of manufacturing a nano-gap electrode whose two electrode portions have a gap ranging from 4 nm to 6 nm comprising:

a deposition step of vacuum vapor-depositing a Pt layer from 10 nm to 15 nm in thickness as an adhesion layer, an Au layer from 60 nm to 80 nm in thickness as an electrode layer, and a Ti layer from 40 nm to 50 nm in thickness as a metal mask layer by a sputter vapor-deposition method in this order on an insulating substrate from 200 nm to 400 nm in thickness;

a mask pattern forming step of making Ga^+ ions impact against the metal mask layer at a dose from 10^{17} to 10^{18} ions/cm^2 by using a focused ion beam including the Ga^+ ions and having a minimum diameter from 10 nm to 15 nm and accelerated by an acceleration voltage from 25 kV to 40 kV and thereby etching the metal mask layer and forming a mask pattern; and

a dry etching step of etching an electrode layer including the Au layer and the Pt layer by sputter etching using Ar^+ ions and thereby patterning the electrode layer; and

a wet etching step of dipping the metal mask layer in an acid water solution containing sulfuric acid and thereby removing the metal mask layer.

16. The method of claim 15, wherein the thickness of the insulating substrate is 300 nm, the thickness of the Pt layer is 12 nm, the

thickness of the Au layer is 70 nm, the thickness of the Ti layer is 45 nm, the acceleration voltage of the Ga^+ ions is 30 kV, the minimum diameter of the Ga^+ ion beam is 12 nm, and the gap between two electrode portions of the nano-gap electrode is 5 nm.

17. A method of making a nanostructured layer, comprising:

providing a substrate comprising a first layer located over the substrate and a metal mask layer over the first layer;

etching the metal mask layer using focused ion beam and thereby forming a mask pattern; and

selectively etching an exposed portion of the first layer using the mask pattern as a mask to form an opening having a size of 2 nm to 12 nm in the first layer.

18. The method of claim 17, further comprising selectively removing the metal mask layer from the etched first layer.

19. The method of claim 17, wherein:

the first layer comprises a metal electrode layer;

the step of selectively etching an exposed portion of the first layer comprises selectively dry etching the metal electrode layer;

the step of selectively removing the metal mask layer comprises selectively wet etching the metal mask layer; and

the opening comprises a nano-gap in the metal electrode layer having a size of 2 nm to 10 nm.

20. The method of claim 17, further comprising placing an organic molecule in the opening in the first layer, wherein the first layer comprises a conductive layer.

21. A nano-gap electrode in which a gap between two electrode portions constituting an electrode layer ranges from 4 nm to 6 nm.

22. The nano-gap electrode of claim 21, wherein:
the nano-gap electrode is located on an insulating substrate; and
the electrode layer comprises at least one of gold and platinum.

23. The nano-gap electrode of claim 21, further comprising an individual organic molecule located between the two electrode portions.